

Reply to Comment on “Absence of electron dephasing at zero temperature”

T.R.Kirkpatrick

*Institute for Physical Science and Technology, and Department of Physics
University of Maryland,
College Park, MD 20742*

D.Belitz

*Department of Physics and Materials Science Institute
University of Oregon,
Eugene, OR 97403
(February 1, 2008)*

We explain why the objections raised by Golubev et al. in a comment on cond-mat/0111398 are not valid.

In a recent comment [1] on our paper [2], Golubev et al. raise two objections to our proof that the Cooperon is massless at zero temperature. They claim that, (1) the electron-electron interaction breaks time-reversal invariance, and (2) our proof breaks down for the case of a Coulomb interaction, as opposed to a short-ranged interaction. We disagree with both of these arguments.

Concerning (1), it is well established that interacting many-particle systems, classical or quantum, are time reversal invariant in equilibrium in the absence of external magnetic fields or magnetic impurities [3]. Time reversal is an exact symmetry of our starting Hamiltonian, as well as the one studied by the authors of Ref. [1]. This leads to the exact symmetry of the Green function used in Ref. [2], which in turn relates the diffuson and Cooperon, respectively. To avoid misunderstandings we stress again, as we have in Ref. [2], that this relation holds for the disconnected (with respect to the interaction) parts of the particle-hole (“diffuson”) and particle-particle (“Cooperon”) correlation functions only [4].

Concerning (2), there is no difference in the behavior of systems interacting via a Coulomb interaction and a short-ranged interaction, respectively, in dimensions $d > 2$. Furthermore, it has been shown in Ref. [5] how to generalize our Ward identity to deal directly with a bare Coulomb interaction, if this is desired. This procedure is substantially more involved than the simple limit taken in Ref. [1].

In summary, the objections raised by Golubev et al. are not valid.

- [1] D.S. Golubev, A.D. Zaikin, and G. Schön, cond-mat/0111527.
- [2] T.R. Kirkpatrick and D. Belitz, cond-mat/0111398.
- [3] See, e.g., L.P. Kadanoff and P.C. Martin, Ann. Phys. **24**, 419 (1963).
- [4] R. Raimondi, P. Schwab, and C. Castellani, Phys. Rev. B **60**, 5818 (1999) have given a detailed discussion of this point.
- [5] D. Belitz, F. Evers, and T.R. Kirkpatrick, Phys. Rev. B **58**, 9710 (1998). This is Ref. 19 in [2].

ACKNOWLEDGMENTS

This work was supported by the NSF under Grant Nos. DMR-99-75259 and DMR-98-70597.